Learning from errors

Displaced stress fracture of the femoral neck in young active adults

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Summary

Stress fractures of the femoral neck in healthy individuals are rare and most prevalent among long-distance runners and military recruits. Women seem to be at higher risk of developing stress fractures because of possible eating disorders and, thereby, following amenorrhoea and osteoporosis. The majority of fractures of the femoral neck are undisplaced. However, they might progress into displaced fractures with avascular necrosis of the femoral head and following development of osteoarthritis as a probable consequence even when treated properly. Early diagnosis with MRI or radionuclide scanning in patients with a history of pain in the groin region during training might be crucial in detecting the fractures at early stages; thereby preventing possible complications following surgical treatment of displaced fractures. The authors present a report of two young adults who developed displaced fractures of the femoral neck and were treated with closed reduction and internal fixation.

BACKGROUND

Bone tissue is a dynamic architectural structure that constantly remodels itself to endure external forces, and respond to changes in the muscular activity imposed on it, more efficiently.^{1 2} An increase of muscle activity results in an increased bone strength but, on the other hand, a decrease in the muscular activity or muscle atrophy results in atrophy of the bone. The homeostasis of the bone tissue requires continuous synthesis and degradation of the bone components. Under normal conditions there is a unique balance between osteoblastic reconstruction of the bone and osteoclastic resorption.^{3–5} An accumulation of abnormal mechanical load to a localised area of bone can disturb the balance in favour of catabolic osteoclastic activity and pathologically enhance the bone resorption.⁴ The osteoclastic activity reaches its maximum approximately 3 weeks after the onset of the repeated stress to the bone.^{3 6 7} Structurally weakened bone would be consequently predisposed to micro-fractures, which could eventually progress to a complete fracture.^{8 9} Repetitive excessive load over a longer period of time could also cause temporary ischaemia to the stressed area and enhance the bone remodelling. The ischaemia might also be explained by impairment of local micro-circulation, where micro-damages of the capillaries would lead to neutrophil activation with subsequent clotting of the affected vessels.^{10–12} Aetiologically, the stress fractures could be divided in to two types. A fatigue fracture is a consequence of an abnormal stress applied to the bone with normal structure and elasticity.^{1 11 13} An insufficiency fracture results from a normal muscle load applied on the bone with deficient structure and elasticity.^{1 11 13} It is most prevalent in older populations and often associated with postmenopausal osteoporosis or other types of osteoporosis caused by rheumatoid arthritis, diabetes mellitus or use of corticosteroids.^{1 11 13 14}

Stress fractures of the femoral neck in healthy individuals represent around 5% of all stress fractures. They have been reported in the literature from as early as 1905 and, since

then, several case series have been published.^{15 16} Stress fractures of the femoral neck are often seen in military recruits and long-distance runners.^{17 18} The most common symptom is groin pain, which is relieved by rest and worsened by activity. The majority of these fractures are undisplaced and do not require surgical treatment. Although rare, they might progress in to displaced fractures with avascular necrosis of the femoral head and the development of osteoarthritis as a probable consequence even when treated properly.^{19 20} Identification of the risk population, early diagnosis and treatment are all key in preventing this serious complication for healthy and physically active individuals. In this paper we report about two patients treated for displaced stress fracture of the femoral neck.

CASE PRESENTATION

Case 1

A 38-year-old female surgeon, slim, physically active and with no former medical history had for 10 days suffered from deep left-sided groin pain. She had been training long-distance running while preparing for a marathon and increased the training intensity to approximately 3 h daily for four to five times a week some months before the pain onset. There were no clear signs of nutritional misbalances identified in the previous history, although it could not be completely excluded. The pain was thought to be caused by overstretch of the inguinal ligaments or tendonitis; therefore, no radiological examinations were performed. The symptoms were treated with non-steroidal anti-inflammatory drugs (NSAIDs) without any satisfactory effect. A few weeks after the onset of the symptoms, while moving her luggage at the airport, she suffered a slight torsion of the left hip and immediately experienced severe pain in her groin/hip region.

Case 2

A 39-year-old male surgeon, with no previous medical history, was examined because of a 3 to 4-week history of deep

Figure 1 Radiographs of displaced tension-type stress fracture of the medial femoral neck treated with closed reduction and internal fixation with three cannulated screws. (A) Preoperative radiographs, (B) postoperative radiographs, (C) 12 months' follow-up.

Figure 2 Radiographs of displaced tension-type stress fracture of the lateral femoral neck treated with closed reduction and internal fixation with dynamic hip screw and plate. (A) Preoperative radiographs, (B) postoperative radiographs, (C) 12 months' follow-up.

pain in the right-side groin region. He was an active recreational runner who had been training very intensively for some time before the onset of the symptoms. In addition, he had a busy time at work with a lot of duties and psychological stress related to that. There was no apparent previous history of nutritional misbalances identified. Initial radiographs did not reveal any pathology in the hip; therefore, he was treated conservatively with NSAIDs. Approximately 1 month after the initial examination, without any history of adequate trauma, he got severe pain in his right hip.

INVESTIGATIONS

On clinical examination, both of the patients could not bear weight, and the lower extremity was clearly shortened and outwards rotated compared to the asymptomatic one.

In both cases, plain radiographs revealed a displaced Garden type 4 fracture of the femoral neck. In case one, the fracture was located in the medial femoral neck and in case two in the lateral femoral neck.

DIFFERENTIAL DIAGNOSIS

One of the relevant differential diagnoses of stress fracture of the femoral neck is chronic sclerosing osteomyelitis. Plain radiographs of this condition might reveal changes that usually extend throughout the bone circumference, affect a larger area than changes associated with stress fractures and the radiographs do not change after few weeks of follow-up.¹⁻³ Other possible differential diagnoses, like osteogenic sarcoma, Ewing's sarcoma, metastasis or osteoid osteoma, should also be considered. Osteogenic sarcoma has the highest prevalence in children and young adults; most of them located in the bone metaphysis. Radiographs might reveal lytic lesions with periosteal reaction and, eventually, Codman's triangles.¹⁻²¹⁻²² Patients with suspect metastatic lesions in the fracture area do often have a previous history of known malignant disease.²³⁻²⁴ Osteoid osteoma is a benign lesion that causes pain, which is worst during the night, and these patients have good pain relief from NSAIDs. As mentioned earlier in the report, pain

caused by stress fractures is worse during exercise and relieved by rest.¹

TREATMENT

Because of the different fracture locations (medial/lateral femoral neck), different surgical approaches were chosen. Patient 1 underwent closed reduction and internal fixation with three cannulated screws—the method considered to give best mechanical support to fractures of the medial femoral neck (figure 1A,B). Because screw fixations do not guarantee enough mechanical support to fractures of the lateral femoral neck, patient 2 underwent closed reduction and internal fixation with dynamic hip screw and a plate (figure 2A,B). The surgery was performed without any preoperative or postoperative complications.

OUTCOME AND FOLLOW-UP

Postoperatively, both patients were advised to partial weight bearing with crutches for 3 months, and both of the fractures showed early signs of union after approximately 12 weeks. At 12 months' follow-up, the plain radiographs of patient 1 did not reveal any clear signs of avascular necrosis of the femoral head (figure 1C). Although she did not have any problems with using her hip in normal daily activities, the most proximal screw needed to be removed because of a slight pain in the trochanter region.

At 12 months' follow-up of patient 2, the plain radiographs also revealed union of the fracture without any sign of avascular necrosis (figure 2C). A couple of years later, the metal was removed because of a slight pain in the hip considered to be caused by the osteosynthetic material. Today, almost 11 years after the initial treatment, he has no subjective problems with the hip.

DISCUSSION

As these two cases show, stress fractures of the femoral neck are frequently associated with young adults who are physically active and running is considered a predominant cause of these types of fractures. The abnormal forces causing the excessive bone resorption may result from increased training intensity, hard training surfaces, inappropriate footwear or incorrect training techniques.²⁵ However, factors like bone composition, vascular supply and poor anatomical alignment of the feet might play an important role as well.¹¹ The higher reported incidence of stress fractures among female athletes could be triggered by a triad of eating disorders, amenorrhoea and osteoporosis.^{3 26} Johnson *et al*²⁷ estimated the global incidence of stress injuries in sports to approximately 2% in men and 7% in women. Benell *et al*²⁸ found a two to fourfold increased risk of stress fractures in women with menstrual disturbances and delayed menarche. Furthermore, Brunet *et al*²⁹ reported that female athletes have up to four times higher risk of bone stress injury. However, some authors reported an equal risk of developing stress fractures in both sexes.^{30 31}

Both of our patients had experienced deep pain in the groin region for several weeks before the acute displacement of the fracture. Although they might belong to risk groups, because of the age and high intensity training the symptoms were diagnosed as tendinitis and treated with NSAIDs. As we know, deep pain localised to the hip or groin region is the most prevalent symptom of stress fractures of the femoral neck. At the early stages the pain is present only during exercise. However, as the bone resorption progresses, the patient could experience intensive pain also at rest.^{3 32 33} Examination with plain radiographs was only performed in the second case and turned out to be normal. More advanced diagnostic procedures like CT, MRI or radionuclide scanning were not carried out in any of the cases. Although plain radiographs are a routine examination, they have only 15–35% sensibility; thus, making the stress fracture difficult to discover in the first weeks after the onset of symptoms.³ That is why careful clinical examination and previous history with focus on recent activities and nutritional status are essential in the diagnostic process.^{32 33} Radionuclide bone-scanning and MRI have nearly 100% sensitivity and should, therefore, represent 'the golden standard' for detecting an early stage stress fracture.³¹

Devas *et al*³⁴ described two types of fatigue fractures of the femoral neck: (1) the compression type, which initially appears on the inferior aspect, and (2) the tension type, which initially appears on the superior aspect of the femoral neck. Compression fractures seem to be more common in young patients, are usually stable and might be treated conservatively. However, the tension type is more unstable and, therefore, is associated with a significant risk of displacement.³³ In our cases, the preoperative radiographs showed displaced, tension-type fracture of the femoral neck.

Although the fractures healed in both of our reported cases, the displacement of stress fractures of the femoral neck might, in spite of proper treatment, lead to avascular necrosis of the femoral head. In a study performed by Visuri *et al*, four cases of avascular necrosis were reported in a group of 12 patients treated with internal fixation.²⁰ Johansson *et al* reported 16 stress fractures of the femoral neck treated with internal fixation and three of the patients developed avascular necrosis.³⁵ Both studies show a significant risk of necrosis after displacement of the fracture; thus emphasising the importance of early diagnosis and aggressive treatment in order to achieve proper fracture-healing and good quality of life afterwards.

Measures to avoid stress fractures of the femoral neck should include proper nutrition, suitable training techniques, training intensity and appropriate foot wear. Close follow-up of athletes with a history of deep groin pain during exercise might, together with swift examination by MRI or radionuclide scanning, be essential in preventing displacement of fractures and possible avascular necrosis of the femoral head as a consequence.

Learning points

- Identification of risk groups, like hard-training young adults, especially female athletes with eating disorders and consequent menstrual disturbances and osteoporosis, is important.
- There should be close follow-up of athletes with history of deep groin pain during exercise.
- Plain radiographs have only 15–35% sensitivity in early stages.
- Radionuclide scanning and MRI is 'golden standard' and have nearly 100% sensitivity.
- Proper nutrition, suitable training techniques, training intensity and appropriate foot wear are important measures to prevent stress fractures.

Competing interests None.

Patient consent Obtained.

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